UNITED STATES DEPARTMENT OF COMMERCE
National Telecommunications and Information Administration
Washington, D.C. 20230

FEB 27 2009

ET Docket No. 09-36

Mr. Julius Knapp
Chief
Office of Engineering and Technology
Federal Communications Commission
445 12th Street, SW
Washington, D.C. 20554

Dear Mr. Knapp:

The National Telecommunications and Information Administration (NTIA) has had ongoing staff-to-staff discussions with the Federal Communications Commission (FCC) regarding the petition for rulemaking to establish a new Medical Micropower Network (MMN) Service in the band 413-457 MHz.[1] As you are aware the 413-450 MHz band is used by federal agencies for land mobile radio and radar operations. While NTIA agrees that the devices described in the petition have the potential to significantly improve the quality of life for countless Americans suffering from spinal cord injuries, traumatic brain injuries, and strokes, we are concerned that there may be electromagnetic compatibility issues associated with the proposed MMN Service medical devices and current and future federal systems operating in the band.

In our discussions the FCC requested that NTIA provide information on the current operational federal systems in the band 413-450 MHz. Enclosure 1 provides a summary of representative technical parameters of the systems operating in this band. It should be noted that these are typical current systems and the technical parameters could change in the future if new systems are developed. Enclosure 2 identifies technical issues related to the electromagnetic compatibility between MMN Service devices and federal systems that should be addressed as part of this rulemaking proceeding.

If you have any additional questions the NTIA point-of-contact on this issue is Mr. Edward Drocella (202-482-2608; edrocella@ntia.doc.gov).

Sincerely,

Karl B. Nebbia
Associate Administrator
Office of Spectrum Management

Enclosure(s)

1. *See* "Amendment of Parts 2 and 95 of the Commission's Rules to Establish the Medical Micropower Network Service in the 413-457 MHz band", Petition for Rulemaking, filed September 5, 2007 by Alfred Mann Foundation, placed on *Public Notice* for comment October 3, 2007, (Report No. 2835; RM-11404).

parameters of the federal LMR systems operating in the 413-420 MHz band are given in Table 1.

Table 1.

Representative Technical Parameters of LMR System Operating in the 406.1-420 MHz Band

Parameter	Value
Tuning type; range	Fixed frequencies; 406.1-420MHz
Mean RF output power (Watts)	10-90
Modulation	Frequency Shift Keying 4 Level
Antenna gain (dBi)	6
Transmitter RF emission curve	–3 dB 4 kHz –20 dB 18kHz –40 dB 24 KHz
Receiver IF selectivity	–3 dB 8.5 kHz –20 dB 15 kHz
Antenna Polarization	Vertical
Receiver Sensitivity (dBW)	-146

Radar Operations in the 420-450 MHz Frequency Range

The band 420-450 MHz is allocated on a primary basis for the radiolocation service and is used by federal ground-based, airborne, and shipborne radar systems for long-range surveillance. These uses are essential to the nation's aerospace early warning defense capability. The radar systems operating in this band transmit very high power pulsed signals. The radar systems can operate on a single frequency, use chirped frequency modulation schemes across a wide frequency range,[4] or transmit across the entire band employing spread spectrum frequency hopping techniques.[5]

Ground-Based Radars. The frequency band 420-450 MHz provides unique characteristics that are ideal for very long range detection, identification, and tracking of objects. Space object tracking and cataloging are accomplished in this frequency band using Mega Watt (MW) transmitter powers and high antenna gains.[6] The radars operate

4. Chirp modulation, or linear frequency modulation is a type of modulation that employs sinusoidal waveforms whose instantaneous frequency increases or decreases linearly over time. These waveforms are commonly referred to as linear chirps or simply chirps.

5. Frequency-hopping spread spectrum (FHSS) is a method of transmitting radio signals by rapidly switching a carrier among many frequency channels, using a pseudorandom sequence known to both transmitter and receiver.

6. A mega Watt is 1 million watts.

continuously; around the clock and year round. They scan from a surveillance "fence" of approximately 3 degrees up to 60 degrees in elevation, in 120 degree sectors in azimuth. The radar receivers are extremely sensitive in order to detect returns from exo-atmospheric and space objects. Because of their specialized function and requisite design characteristics (e.g. very large antenna arrays), these particular ground-based radars are not numerous, but because of their sensitivity and function they deserve special recognition and protection.[7] The representative technical parameters of the federal ground-based radar systems operating in the 420-450 MHz band are given in Table 2.

Table 2.
Representative Technical Parameters of Ground Radars in the 420-450 MHz Band

Parameter	Value
Tuning type; range	Frequency agile; 420-450 MHz
Peak RF output power (Mega Watts)	1-5
Polarization	Circular
Pulse duration (millisecond)	0.25, 0.5, 1, 2, 4, 8, 16
Duty cycle (average) (percent)	25
Pulse frequency modulation (linear chirp)	Search: 100-350 kHz chirp track: 1 or 5 MHz chirp
Pulse repetition rate (Hz)	Up to 41
Antenna type	Planar array; 22+ meter diameter
Antenna gain (dBi)	38.5
Antenna scan	3-85 degree elevation; ±60degree azimuth per each of 2 planar arrays for total 240degree azimuth scan
Antenna beamwidth (degrees)	2.2 elevation 2.2 azimuth
Receiver noise temperature (K)	≤ 450
Receiver bandwidth (MHz)	1 or 5 (see chirp width)

Airborne Radars. The 420-450 MHz band has been and will continue to be essential for the development and operation of airborne radar surveillance systems. These systems operate, for extended periods (hours to days) once in their intended areas of operation. Long range object detection, acquisition, and tracking are essential functions of these radar systems. Ground-based radars are limited by the radio horizon, and the employment of long range radars on airborne platforms is an excellent way to extend the capability of individual radar systems. Similar to ground-based air surveillance radars, airborne radars employ rotating scans in azimuth and scan over a specified range in

7. The locations the ground-based radar systems are specified in Part 15.240 of the Federal Communications Commission Rules.

elevation, either by electronically scanning in elevation or by using a relatively wide elevation beamwidth. The radar system operates during aircraft ascent and descent as well as at operating altitudes; typical aircraft ceiling altitude is around 9 kilometers with a line-of-sight distance of approximately 400 kilometers. Both the Department of Defense and the Department of Homeland Security use airborne radar systems in the 420-450 MHz band and operating throughout the United States. The representative technical parameters of the federal airborne radar systems operating in the 420-450 MHz band are given in Table 3.

Table 3.

Representative Technical Parameters of Airborne Radars Operating in the 420-450 MHz Band

Parameter	Value
Tuning type; range	Fixed frequency or frequency agile; 420-450 MHz
Peak RF output power (MW)	2
Polarization	Horizontal
Pulse duration (μs)	1, 2, 4, 8
Pulse modulation	Unmodulated pulses
Pulse repetition rate (kHz)	0.1-2
Antenna type	Yagi element array or planar array
Antenna gain (dBi)	22
Antenna scan	±60 degree elevation (mechanically positioned or electronically scanned); 360 degree azimuth at 3-7 rpm
Antenna beamwidth	6-20 degree elevation (depending upon scan type); 6 degree azimuth
Receiver noise figure (dB)	5
Receiver IF bandwidth (MHz)	1

Shipborne Radars. Shipborne surveillance radars are also operated in the frequency range 420-450 MHz. They normally operate at sea, though operations in littoral waters and naval ports should be expected. As is typical with surveillance radars, the system scans 360 degrees in azimuth, and operations are on a continuous basis. The representative technical parameters of the federal shipborne radar systems operating in the 420-450 MHz band are given in Table 4.

Table 4.

Representative Technical Parameters of Shipborne Radars Operating in the 420-450 MHz Band

Parameter	Value
Tuning type; range	Fixed frequencies; 420-450 MHz
Peak RF output power (MW)	2
Pulse modulation	Unmodulated pulses
Antenna gain (dBi)	30 (mainbeam) 0 (median sidelobe)
Transmitter RF emission curve	–3 dB 2 MHz –20 dB 3 MHz –70 dB 20 MHz
Receiver IF selectivity	–3 dB 2 MHz –103 dB 20 MHz
Receiver noise level (dBW)	–136
Antenna type	Parabolic reflector

Other Radiolocation Systems Operating in the 420-450 MHz Frequency Range

In addition to the military radar systems that operate in the 420-450 MHz band, the U.S. Army operates the Enhanced Position Location Reporting System (EPLRS) radiolocation system in this band. The Air Force system AEPLRS also operates in this band. The EPLRS/AEPLRS is a secure, jam resistant, computer controlled radiolocation network that distributes near real-time tactical information, generally integrated into radio sets, and coordinated by a Network Control Station. EPLRS is primarily used for data distribution and position location and reporting. It enhances command and control of tactical units by providing commanders with the location of friendly units. The EPLRS employs Time Division Multiple Access and uses a frequency hopping, spread spectrum waveform. The representative technical parameters of radiolocation position location systems operating in the 420-450 MHz band are provided in Table 5.

Table 5.

Characteristics of Radiolocation Position Location System Operating in the 420-450 MHz Band

Parameter	Value
Tuning type; range	Fixed frequencies; 420-450 MHz
Peak RF output power (Watts)	0.4, 3, 20, 100
Modulation	Continues Phase Shift
Antenna gain (dBi)	4
Transmitter RF emission curve	–3 dB 3 MHz –20 dB 6 MHz –40 dB 15 MHz
Receiver IF selectivity	–3 dB 3 MHz –103 dB 20 MHz
Antenna Polarization	Vertical
Receiver Sensitivity (dBW)	-133

Other Systems Authorized to Operate in the 420-450 MHz Band

In accordance with Footnote G8, low power federal control operations are permitted in the 420-450 MHz band. Flight termination and command and destruct systems used on federal facilities also operate in this band.[8] The representative technical parameters of low power radio control systems are provided in Table 6. The representative technical parameters of Flight Termination and Command Destruct Systems are provided in Table 7.

8. Flight termination is a mode of control which normally terminates the flight of a vehicle at the end of a mission. The emergency termination of a flight is command and destruct.

Table 6.

Representative Technical Parameters of Low Power Federal Radio Control Systems Operating in the 420-450 MHz Band

Parameter	Value
Tuning type; range	Fixed Frequencies, 420-450 MHz
Mean RF output power (Watts)	1-5
Modulation	Frequency Shift Keying 4 Level
Antenna gain (dBi)	2
Transmitter RF emission curve	-3 dB 5 kHz -20 dB 12 kHz - 40 dB 24 kHz
Receiver IF selectivity	-3 dB 12 kHz -20 dB 44 kHz
Receiver Sensitivity (dBW)	-136

Table 7.

Representative Technical Parameters of Flight Termination and Command Destruct Systems Operating in the 420-450 MHz Band

Parameter	Value
Tuning type; range	420-450 MHz
Mean RF output power (Watts)	1-10,000
Modulation	Multiple Frequency Modulated Tones
Antenna gain (dBi)	26
Transmitter RF emission curve	-3 dB 97 kHz -20 dB 150 kHz - 40 dB 201 kHz

Enclosure 2
Technical Issues Related to Electromagnetic Compatibility Between Medical Devices and Federal Systems in the 413-450 MHz Band

This enclosure identifies technical issues related to the electromagnetic compatibility between the incumbent federal systems and devices operating in the Medical Micropower Network (MMN) Service. It should be noted that the federal systems operating in the 413-450 MHz band can change their technical parameters, therefore, and interference mitigation techniques developed for electromagnetic compatibility should be flexible enough to accommodate these changes or changes in the operational use of the federal system. Within this enclosure, several parameters associated with Alfred Mann petition are addressed; however, it should be recognized that the service rules developed will be applicable for any medical device operating in the MMN Service.[1]

Interference to Incumbent Systems

Based on information in the Alfred Mann petition, the proposed maximum Effective Radiated Power (ERP) level of the Master Control Unit (MCU) is 1 milliwatt.[2] The proposed maximum ERP of the identification (ID) devices is 200 microwatts as measured when implanted in the human body.[3] The proposed ERP levels of the MMN Service system are low when compared to that of the incumbent federal systems. Since the ERP levels of the incumbent systems will be substantially higher than those of the MMN Service system devices, the impact this difference will have on the potential for interference to the incumbent federal systems should be evaluated.

The MMN Service system is capable of operating with up to hundreds of implanted ID devices. Given the potentially large number of implanted devices the potential impact for aggregate interference to incumbent federal systems should be addressed. Techniques that can be employed by the MMN Service devices to mitigate aggregate interference to the incumbent systems should also be evaluated. Based on the analysis results the service rules necessary to minimize the potential for aggregate interference from the MMN Service devices to the incumbent federal systems can be developed.

The ratio of the average power to the peak power is the duty cycle and represents the percentage of time that the power is present. Since the duty cycle proportionally reduces the average power, this may reduce the potential for interference to incumbent systems. As part of the technical analysis, the limits on establishing duty cycles for the MCU and ID devices to preclude interference to the incumbent systems should be

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1. *See* "Amendment of Parts 2 and 95 of the Commission's Rules to Establish the Medical Micropower Network Service in the 413-457 MHz band", Petition for Rulemaking, filed September 5, 2007 by Alfred Mann Foundation, placed on *Public Notice* for comment October 3, 2007, (Report No. 2835; RM-11404).

2. *Id* at 21.

3. *Id.*

considered. The impact of placing additional limitations on the MCU and ID devices to protect incumbent federal systems should be examined.

The analysis assessing potential interference from the MMN Service devices should also include operational factors that are unique to the incumbent federal systems.

Interference to MMNS Systems

Given the types of incumbent federal systems that are allocated in the 413-450 MHz band, the interference effects of high powered systems on the MMN Service devices and ultimately the individuals in whose body the devices operate must be considered. While interference is scenario dependent, scenarios are possible where a recipient of MMN Service implants could be in close proximity, or in the field of view, and illuminated by a high-powered radar system, resulting in unknown and potentially devastating effects to the individual. However, there are techniques that could be employed by MMN Service systems to greatly reduce the potential for interference. Several examples of interference mitigation techniques that could be required for MMN Service systems are described below. These include but are not limited to: error detection and correction coding, spectral notching, and dynamic channel switching. Parties submitting comments should be requested to identify other interference mitigation techniques that could be employed by MMN Service devices.

Error Detection and Correction Coding. Error detection and correction coding is a commonly used technique for detecting and limiting the effects of interference. Error detection and correction coding permits the detection and correction of errors. When a MMN Service system detects message errors that cannot reliably be corrected, the MMNS system can employ a retransmission protocol. If the message rate is high enough there is time for retransmission of missed messages. Forward Error Correction (FEC) techniques, where errors are detected and corrected at the receiver without repeating the transmissions can also be employed. For example, a FEC Reed–Solomon code with an interleaver[4] is an effective scheme to mitigate the effect of low duty cycle pulsed interference.[5] The effectiveness of an error detection and correction coding technique is highly dependent on the type of interfering signal and needs to be evaluated as part of this rulemaking proceeding.[6]

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4. Interleaving is the process of shuffling a coded bit sequence prior to modulation and reversing this operation following demodulation. This is used to separate and redistribute burst errors for a higher probability of correct decoding by codes designed to correct random errors.

5. Department of Defense, Joint Spectrum Center, JSC-PR-04-007, *EMC Analysis of Universal Automatic Identification and Public Correspondence Systems in the Maritime VHF Band* (February 2004).

6. The effect of pulsed interference is more difficult to quantify than continuous wave interference and is strongly dependent on receiver/processor design. The NTIA laboratory in Boulder, CO has conducted tests on a particular 4 GHz earth station receiver to determine susceptibility to co-channel pulsed interference. That report (NTIA Report 02-393) is available at (www.its.bldrdoc.gov/pub/pubs.php).[6] It showed that normal forward error correction processing built into the receiver was able to recover from low duty cycle pulsed interference (e.g., less than 1 percent duty cycle) even though (under certain combinations of small pulse widths and pulse repetition rates) the peak interference exceeded the desired signal by 60 dB or more.

Spectral Notching. MMN Service devices can be implemented to employ digital signal processing techniques to create spectral notches to filter out narrow portions of a frequency band containing interfering signals. This spectral notching can typically be accomplished with minimal impact on receiver performance because the rejected energy is only a small fraction of the total signal power. Similar techniques of this sort have been used in military applications for some time and more recently have been found to be effective in non-military applications.[7] In actual implementation, the sampled radio signal is converted to the frequency domain using a windowed Fast Fourier Transform (FFT) process. The narrowband interferers are identified with a peak search algorithm and removed by bin detection. The remainder of the frequency domain signal is then transformed back to the time domain using an inverse FFT process and normal signal demodulation techniques can be used to recover the message.

Dynamic Channel Switching. MMN Service devices can be designed to be capable of dynamically switching to alternate channels if there are available channels can be employed without causing interference to the same or other incumbent systems. This capability would allow MMN Service devices to continually assess channel quality by monitoring the transmissions. When a channel becomes degraded due to a strong wideband interfering signal (*e.g.*, radar system) or a large number of narrowband interfering signals (*e.g.*, land mobile radio systems), the MMN Service devices can identify an alternate channel and switch to that channel if it is available. An example of this spectrum sharing technique has been implemented in the 5 GHz band for sharing with radar systems.[8] As a result of the rulemaking the technical parameters of the dynamic channel switching technique will have to be developed.

Measurements to Verify Effectiveness of Interference Mitigation Techniques

Given the diverse nature of the incumbent systems operating in the 413-450 MHz band it may difficult to implement interference mitigation techniques that are optimized for the different types of signals. For example, land mobile radio (LMR) systems by their very nature are mobile, and the signal power can vary in time and span a range as great as 100 dB in power – the weakest signals typically coming from distant transmissions and the stronger signals typically coming from nearby base stations and local mobile and portables. Not only can a system operating on a single frequency vary greatly in power from time to time, but power can vary greatly between adjacent frequencies. Because of this broad range of signal powers, depending upon the degree of sensitivity of a MMN Service device attempting to detect an LMR system must have a wide instantaneous dynamic range (*i.e.*, be able to resolve the individual signal powers without varying the

7. *Comparing Traditional FFT Based Frequency Domain Excision with Poly-Phase Transform Excision*, Published in Proceedings of the 55th Annual Institute of Navigation Conference, Navigational Technology for the 21st Century, at 625-634.

8. Dynamic Frequency Selection (DFS) is being employed to facilitate sharing between ground-based military radar systems and unlicensed radio local area networks. DFS is a mechanism that dynamically detects radar signals and avoids co-channel operation. *See* 47 C.F.R. Part 15 Subpart E.

sensitivity of the system across the detection bandwidth). An error detection and correction coding technique that works well for a low duty cycle pulsed radar signal may prove to be ineffective for analog or digital LMR signals. The detection threshold used in an algorithm for dynamic channel switching for ground-based radar systems will be different than that used for detecting airborne radar systems. The merits of employing detection and avoidance techniques for wideband systems (e.g., 5 MHz) in a congested LMR signal environment will also need to be addressed as part of this rulemaking proceeding.

There are no analytical techniques that can be employed to assess the effectiveness of an interference mitigation technique. Measurements are necessary to verify that the interference mitigation techniques will actually protect the MMN Service systems and the individuals that rely on them. To accomplish this, coordinated measurement efforts with the incumbent spectrum users are necessary. The MMN Service devices should be thoroughly evaluated prior to initiating a measurement program with the incumbent spectrum users. The authorization of the MMN Service will be subject to the successful completion of measurements that verify the interference mitigation techniques employed protect MMN Service devices from incumbent systems. The agreed upon interference mitigation techniques necessary to protect incumbent users will be included as part of the service rules for MMN Service devices developed as part of this rulemaking proceeding.